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OCCUPATIONAL PHYSICAL ACTIVITY AND COLON CANCER RISK IN TURKEY

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A case-control study of 107 colon cancer cases and 486 controls from an oncological clinic in Istanbul was conducted to examine the association between occupational physical activity and colon cancer in Turkey, where incidence of this disease is low.

Only two of the four activity measures showed evidence of an increased colon cancer risk for sedentary jobs (time spent sitting OR = 1.5 and occupational energy expenditure OR = 1.6); neither was statistically significant. Subjects below age 55 showed higher risk associated with sedentary jobs than did the older age group, probably due to their adoption of a more western lifestyle, including dietary habits, less activity, and other factors that may interact to increase the risk of colon cancer.

INTRODUCTION

Colon cancer incidence varies considerably around the world (5, 41). High rates occur in North America and New Zealand, intermediate rates in Europe, and low rates in Asia, Africa and Latin America. The subsite distribution throughout the colon is generally similar in these areas (7). Rates decrease from ascending colon towards the descending colon with a sharp increase at the sigmoid colon, although there may be a deficit of sigmoid cancers in low-risk areas. Dietary factors are generally thought to be the major determinant of colon cancer (28), although precise dietary constituents and mechanisms remain to be clarified. In recent years, however, several studies have investigated the association between colon cancer and physical activity. The majority of these studies, all but one in developed countries, have shown an increased risk among physically inactive men (2-4, 11, 12, 14, 15, 21-25, 28, 29, 32, 36-38, 40).

We conducted a case-control study of colon cancer in the Marmara region of Turkey to investigate the influence of occupational physical activity in a developing country. No statistics are available on colon cancer specifically in Turkey, but with a mortality rate of 3.22/100,000 among men and 3.15/100,000 among women, cancer of the intestines is the sixth and fifth most common tumors, respectively (10). Turkish mortality rates for intestinal cancer are about 1/5 of the U.S. rates, 1/4 of the European rates, and are similar to Costa Rica and Venezuela (5).

MATERIALS AND METHODS

Study population

The Turkish Social Security Agency (SSA) provides medical care for all workers (including

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retirees) in Turkey. Within this organization is the Oncological Clinic in Istanbul, the largest cancer therapy center (treating all except hematopoietic cancers) for employees in the Marmara Region. Marmara is the most industrialized area in Turkey and includes Istanbul. Due to its reputation, this clinic also provides services to some employees from other regions in Turkey. To evaluate occupational risk factors for cancer we identified 7,242 cancer cases at the SSA between 1979-84. For each case, we obtained a complete work history from the patient at the admission time, diagnosis with histological verification, and information on alcohol and tobacco use.

In this report we describe a case-control study of colon cancer aimed at investigating the influence of occupational physical activity. Cases included 94 males and 13 females. The controls were 486 cancer cases other than colon, rectum, and lung cancer randomly chosen from the 7,242 patients attending the Oncological Clinic during the same period. After removing subjects with no information on occupation or smoking, 87 male and 13 female cases and 371 controls remained.

Physical activity indices

Assessment of occupational physical activity was based on job title and industry names. Measures of activity scales included sitting time, energy expenditure, and two occupational activity scales. The sitting time scale and the total energy expenditure scale were developed by two of the authors, an occupational physician (R.V.), and an industrial hygienist (M.D.) with experience in Turkish work environments. The sitting posture scale was to develop a measure of motionless posture especially for the abdomen. Low activity level was defined as more than 80% of working hours (more than 6 hours a day) spent sitting. Moderate activity was 20-80% of time (2-6 hours a day) spent sitting, and high activity was sitting less than 20% of the time (less than 2 hours a day). These categories parallel those previously used in occupational physical activity studies (4, 12, 14, 25).

The energy expenditure measure was based on a rating system developed by Hettinger *et al.* (17). Low activity included work with an energy expenditure less than 8 KJ/min corresponding to activities such as sitting with only hands working, moderate one arm work or light two arm work (e.g. office work, light sorting work or driving a car). Moderate activity was defined as work energy expenditure of 8-12 KJ/min, corresponding to activities such as walking on a flat surface with a speed of 3 km/h, heavy one arm work or moderate two arm work (e.g. picking or sweeping). High activity was an average work expenditure of more than 12 KJ/min, corresponding to activities like walking on a flat surface with a speed of more than 4 Km/h, heavy two arm work, or light to heavy body work (e.g. wall painting, wall paper hanging, tile setting up to gravel showeling or jack hammer operating).

Midpoint of sitting time (sedentary = 7 hr; moderate = 4 hr; or highly active = 1 hr) and energy expenditure (sedentary = 4 KJ/min; moderate = 10 KJ/min; or highly active = 14 KJ/min) scales was used as weight for each job activity to be multiplied with the duration of employment at that particular job held by the subject for the calculation of cumulative occupational physical activity scores for the subject. Cumulative activity scores were then divided by total duration of employment to obtain average level of physical activity over lifetime employment.

We also applied the occupational activity scheme developed by Garabrant *et al.* (5): highly active (when physical activity was required more than 80% of the time), moderately active (20-80% of the time), and sedentary (less than 20% of the time). Finally, we used the physical activity indices as rated by the Department of Labor (DOL) in their Estimates of Worker Trait Requirements (35). The DOL observed workers performing their jobs and classified them in five degrees of physical activity considering the physical requirements of lifting, pushing, and pulling taking into account intensity and duration. To make this index comparable to the other scales we collapsed the two highest and two lowest activity measures. In addition to the occupational activity indices, a socio-economic status index was assigned for every case and control based on job titles.

Statistical analysis

The odds ratio (OR) was the measure of association between physical activity indices and colon cancer. ORs were adjusted for age and smoking. Smoking was inversely associated with colon cancer in our data. Gart's method (13) was used to calculate maximum likelihood estimates of the odds ratio and corresponding 95% confidence intervals. The highest level of physical activity served as the referent group. We evaluated the linearity of trends in risk corresponding to the level of activity using Mantel's one tailed test (20). ORs were also computed for colon subsites and histologic types (e.g., adenocarcinoma and the subtype of mucinous adenocarcinomas) when more than 8 cases were available.

RESULTS

Table 1 presents the number of subjects by age, sex, colon subsite, and histologic type. Age distribution ranged from 14 to 97 years, with a median age of 50 years. ORs adjusted for age and smoking are shown for males in Table 2. ORs were not related to activity indices developed by Garabrant *et al.* (12) or DOL (35), but the ORs associated with low activity level were 1.5 for sitting timer and 1.6 for energy expenditure. For females (not shown), the risk was increased for sedentary jobs in the DOL index (OR = 1.8) and sitting time index (OR = 1.5). None of these ORs in either sex were statistically significant, nor were the trends.

TABLE 1 - Description of study data.

Age	cases/controls	male	female
< 45	cases	38	6
	controls	116	23
46-55	cases	23	4
	controls	90	20
56 +	cases	26	3
	controls	108	14
Total	cases	87	13
	controls	314	57
colon subsites (cases):			
cecum (ICD-0 153.4)		27	3
ascending colon (ICD-0 153.6)		1	0
transverse colon (ICD-0 153.1)		8	1
descending colon (ICD-0 153.2)		3	0
sigmoid colon (ICD-0 153.3)		17	5
unclassified		21	5
histologic types (cases):			
adenocarcinoma		56	11
mucinous adenocarcinoma		13	0
other types		3	2
unclassified		15	0

TABLE 2. - Odds ratios for colon cancer among men adjusted by age and smoking according to occupational physical activity indices.

Type of index	level	no. cases	OR-ML	95% Confidence Interval	Trend Test p-value
Sitting	high	46	1.0		$X = 1.06$
Time	mod.	22	1.0	0.5-2.0	$p = 0.145$
	sed.	19	1.5	0.7-2.9	
Energy	high	14	1.0		$X = 1.07$
Expenditure	mod.	41	1.5	0.7-3.3	$p = 0.143$
	sed.	32	1.6	0.8-3.6	
Garabrant	high	15	1.0		$X = -1.00$
et al.	mod.	71	0.8	0.4-1.6	$p = 0.158$
	sed.	5	1.0	0.3-4.0	
Department	high	40	1.0		$X = 0.17$
of labor	mod.	13	0.9	0.4-1.9	$p = 0.434$
	sed.	38	1.0	0.5-1.7	

Table 3 presents smoking-adjusted risks by age groups for males using the energy expenditure index for physical activity. No trends were evident for any age group for the activity measures by Garabrant, DOL or sitting time. For the energy expenditure measure, risk was increased among the sedentary group, particularly under age 45 (OR = 1.9). Analysis by colon subsites showed that risk associated with sedentary jobs was higher for tumors of the transverse colon than for other segments. However, this excess risk of transverse colon tumor was not significant. Cell type evaluation revealed a significant increasig trend ($p = 0.038$) for mucinous type of adenocarcinoma, based on 13 cases, with an OR of 5.0 for sedentary jobs. Analysis by socio-economic status revealed no clear association with colon cancer risk.

TABLE 3. - Odds ratios for males in different age groups for the energy expenditure physical activity index adjusted for smoking.

	Physical activity level		
age	high	moderate	sedentary
< 45	1.0 (5)	1.3 (17)	1.9 (16)
46-55	1.0 (5)	1.8 (10)	1.6 (8)
56 +	1.0 (4)	1.5 (14)	1.3 (8)

* number of cases in parenthesis.

DISCUSSION

Our study presents a vague inverse association between colon cancer and physical activity that has been reported in developed countries (2-4, 11, 12, 14, 15, 21, 22, 24, 25, 29, 32, 36, 37, 40). The risk of colon cancer was slightly elevated among persons holding jobs performed while sitting and those estimated to have low occupational energy expenditure, particularly at younger ages.

Although based on small numbers, a significant trend of increased risk for sedentary jobs occurred for the mucinous type of adenocarcinoma, which is found more often in young people and has a worse prognosis than the usual form adenocarcinomas (9). This may contribute to the association prevailing among the young patients. No association was noted using two other physical activity scales, employed in earlier reports (4, 12, 25, 36-38). The negative findings may be due to our transfer of job activity rating systems designed for U.S. working environments to a developing country, whereas the positive findings were based on activity indices we developed in the context of working conditions in Turkey. For example, technological differences between the U.S. and Turkish industries may create different physical activity patterns among workers in the U.S. and Turkey. This shows that direct transformation of the occupational physical activity indices from one country to the other does not necessarily reflect the effect on the risk.

A limitation of our study was the use of other cancer cases as controls, which was dictated by our utilization of data from an oncology clinic. We are aware of the potential problems using such a control group (19. 33). Lung cancer was excluded from the controls because an inverse association with physical activity was reported recently (2).

The explanation for the differences in magnitude between our findings and those from earlier reports is unclear, but several possibilities exist. Our results may be simply due to chance, particularly in view of small numbers involved. While chance is often considered as a possible explanation for positive findings, it can also explain a negative report on a true association. In addition, occupational exertion may not be a good measure for overall physical activity among Turkish workers. Non-occupational physical activity in Turkey is much higher than in western countries because it is often necessary to walk to bus stops, work, or shops, since most workers do not own a car. Misclassification of physical activity would also reduce the association, but misclassification in our study should not be ubstantially different from earlier reports noting strong associations.

The major risk factor for colon cancer is thought to be a diet high in fat and low in fiber, including fruit and vegetables (38, 39). The usual Turkish diet is rich in foodstuffs containing high amounts of starch and fibers including dried beans, rice, eggplants, and squash and much lower in meat and fat content than the western diet. The mechanism through which physical activity affects colon cancer risk may include increased gut motility (6, 18, 26, 27), and decreased transit time, which reduces the contact time between fecal carcinogens and colonic mucosa. Physical activity may also influence risk by effects on immune function (31), gastro-intestinal hormones or growth factors (34), cholesterol and bile acids (30) and various other mechanisms (1, 8, 16). If the exposure level to dietary carcinogens is low, however, the modulating effect of physical activity on colon cancer might be limited. It is interesting that a study from China, another developing country, also did not find a strong association between physical activity and colon cancer for men (38). The inverse association between physical activity and colon cancer among the younger workers in our study may reflect societal changes in Turkey, which is experiencing westernization of dietary habits, and greater automation, leading to less strenuous jobs and less non-occupational physical activity. Younger segments of society are likely to more readily adopt new lifestyles, including dietary and sedentary habits that increase the risk of colon cancer. A similar age differential in risk associated with physical activity can be seen also in the United States (36). However, developing countries (e.g.,

Turkey) with changing exposures and risks afford special opportunities for epidemiologic research to elucidate the lifestyle and nutritional determinants of colon cancer.

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